WATER RESEARCH STRATEGY

ASRA
Alberta Science and Research Authority

January 2006

Table of Contents

Alberta's Water Research Strategy — Summary 1

1.0 Importance of Water Knowledge and Research 2

2.0 Development of the Water Research Strategy 3

3.0 Vision, Mission, Values and Goals 4

4.0 Research and Innovation Strategies and Priorities 5

5.0 Success Through Partnership 7

6.0 Measuring Success 7

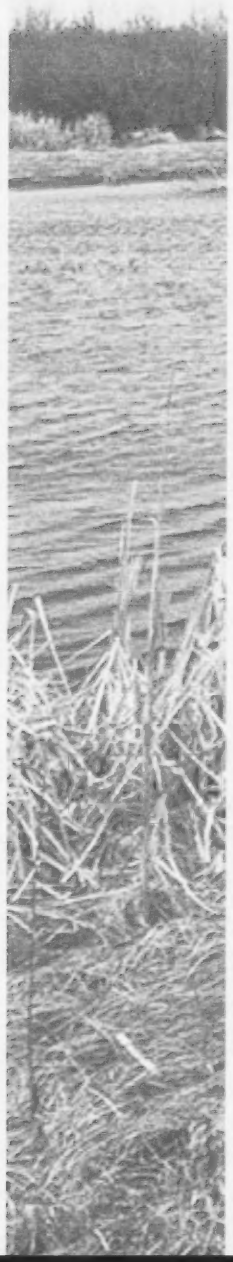
7.0 Sustained Funding and Implementation 8

Appendix 1: Alberta's Water Research System: Strengths, Weaknesses, and Characteristics 9

Appendix 2: National and International Arena: Opportunities and Challenges 11

Appendix 3: Research Questions 12

Appendix 4: Water for Life Strategy Map 16



Front cover photo credits
Main image – Alberta Research Council
Beach, Jean Family Boat Launch, Fort McMurray – Travel Alberta
Cutthroat Trout Fishing, Oldman River – Travel Alberta
Research Lab – Alberta Research Council

Water Research Steering Committee

This strategy was developed by the Alberta Science and Research Authority in collaboration with the Alberta Water Council under the leadership of the following individuals:

Bill Berzins
Fossil Water Corporation

Darrel Danyluk
Calgary Centre for Innovative Technology

John Donner
Alberta Agriculture Food and Rural Development

Ron Dyck
Alberta Innovation and Science

Linda Van Gastel, (Chair)
Alberta Science and Research Authority

David Hill
Alberta Irrigation

Bill Hunter
Alberta Forestry Research Institute

Steve Moran
Alberta Research Council

Bev Yee
Alberta Environment

Alberta's Water Research Strategy — Summary

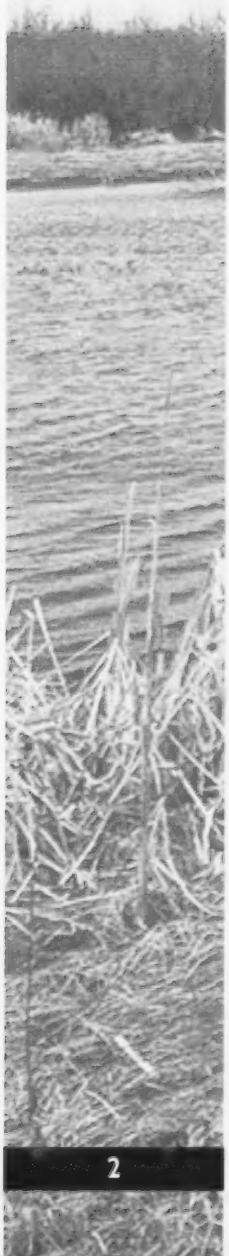
Vision: Albertans have the knowledge required and use that knowledge to ensure the long term safety, health and sustainability of our water resources.

Mission: The ongoing provision, to Albertans and to Alberta's water managers and decision makers, of the knowledge and solutions necessary to achieve the goals of ***Water for Life***: safe secure drinking water, healthy aquatic ecosystems, and reliable quality water supplies for a sustainable economy.

Goal	Strategy	Initial Priority	Implementation	Target Date
To provide science-based information, analysis and technologies to inform and support the decisions and actions needed for effective water management in Alberta.	Improve the safety and security of Albertans' drinking water through knowledge and research.	Develop water treatment technologies and systems to improve public health, especially in areas reliant on private or small water treatment systems.	Action teams and detailed research plans developed and initiated.	December 2006
	Foster improved management of water in the landscape through knowledge and research.	Understand and measure aquatic ecosystem health.	Action teams and detailed research plans developed and initiated.	December 2006
	Improve sustainability of water use through knowledge and research.	Understand ground water resources and interactions with surface water.	Action teams and detailed research plans developed and initiated.	December 2006
To develop an integrated, effective water research system in Alberta that is focused on meeting the strategic knowledge and research needs of ***Water for Life*** and on translating knowledge into action.	Develop a water knowledge management and brokering function to support water management decision making.	Develop a comprehensive knowledge brokering and transfer mechanism or office.	Knowledge management and brokering mechanism established and operational.	June 2006
	Establish a collaborative governance and leadership mechanism to develop and manage an integrated water research system to address the knowledge and research priorities of ***Water for Life***.	Establish the leadership mechanism to work on behalf of government, the Alberta Water Council and ASRA to implement the research strategy.	■ Alberta Water Research Leadership established ■ Funding mechanism established	April 2006 (first meeting) June 2006
	Create multi-disciplinary, high quality, adequately resourced research and innovation teams.	Create action teams to develop and implement the knowledge and research plans needed to achieve the three outcomes of ***Water for Life***.	Action teams and detailed research plans developed and initiated.	December 2006

1.0 Importance of Water Knowledge and Research

Water is critical to Alberta's long term prosperity and environmental sustainability. Alberta developed ***Water for Life: Alberta's Strategy for Sustainability*** to address existing and future water issues. ***Water for Life*** recognizes that achieving the goals of safe secure drinking water, healthy aquatic ecosystems and reliable quality water supplies for a sustainable economy will require a strong foundation of knowledge to enable well-informed management decision-making and to improve water management practices. Action is needed so we do not jeopardize Alberta's future through sub-optimal management of our water resources, but rather continue to develop Alberta as the best place to live, work, and visit.



Some of Albertans' key questions about water are:

How can we assure continued access to quality drinking water? Water treatment systems continue to be challenged by new contaminants, population growth is increasing demand and over 600,000 Albertans are currently using private or unregulated water systems.

How can we best maintain and improve the health of Alberta's aquatic ecosystems? Population growth, expansion of agriculture, energy, forestry and other industries and climate change all present challenges to Alberta's aquatic ecosystems. In areas of high population and industrial development, ecosystem health is especially challenged.

How can Alberta have sustainable growth with a finite water supply? Agriculture, conventional oil and gas, the oil sands, forestry and other industries all require a secure supply of quality water for growth, as does Alberta's population. Water resources are over-allocated in some areas of southern Alberta and water requirements for major economic activity in the oil sands and other industries could also reach limits of available water supplies without new technologies and practices for managing water use.

Addressing these and other questions about our water resources will require sound knowledge about these resources, and about the best water management practices and technologies applicable to Alberta. It will require effective use of many sources of knowledge including scientific, cultural and traditional knowledge. Innovation based on research, data, and information collection and analysis that is related to desired water management outcomes will be required to close knowledge gaps and develop improved technologies. It will also be important to understand and leverage work done in other jurisdictions. Finally, we must ensure that knowledge is readily available to decision-makers and Albertans to support their efforts at effective management of Alberta's water. ***Water for Life*** identifies knowledge and research as a key means of achieving Alberta's water goals.

2.0 Development of the Water Research Strategy

Alberta has significant research, development and innovation capacity to address ***Water for Life***'s knowledge needs (Appendix 1), but for increased effect, this capacity must be marshalled and focused on priority outcomes. A comprehensive, coherent and integrated strategy and action plan is needed to frame and guide this work, and to ensure that the knowledge needs of ***Water for Life*** are met. The Alberta Science and Research Authority, working in collaboration with the Alberta Water Council, established the Water Research Steering Committee to guide the development of Alberta's Water Research Strategy.

This strategy was developed in light of three key context elements:

- Alberta's existing policy and strategic framework related to water as identified in strategies including:
  - *Today's Opportunities, Tomorrow's Promise: A Strategic Plan for the government of Alberta*
  - *Water for Life: Alberta's Strategy for Sustainability*
  - *Growing our Future: An Integrated Life Sciences Strategy for Alberta*
  - *Alberta's Agricultural Research and Innovation Strategic Framework*
  - *Alberta's Commitment to Sustainable Resource and Environmental Management*
  - *A Health Research Strategy for Alberta*
  - *The Forestry Research Strategy*
  - *Alberta's Rural and Regional Development Strategy*
  - *The Alberta Energy Innovation Strategy*
  - *Securing Tomorrow's Prosperity: Alberta's overarching economic strategy*
- The national and international water and water research context (Appendix 2), and
- The views of Alberta's water and water research stakeholders. Over 100 individuals were consulted in interviews and workshops, including:
  - leaders of Alberta's research foundations and institutes
  - water basin councils and stewardship groups
  - non-governmental organizations
  - industry, universities and colleges
  - resource managers and regulators
  - economic development and technology commercialization organizations

During the strategy development process, several complex aspects of water and water management were identified:

- Water is a public and shared resource,
- Water management often requires solutions built on multiple perspectives, and
- Water management is a dynamic activity requiring the ongoing development and application of new knowledge.

A successful Alberta approach to water research and knowledge management must be based on a systems and multidisciplinary approach, ensuring that knowledge and research are publicly and readily available for effective management of Alberta's water resources. Successful implementation of the strategy will require a detailed research and knowledge planning process, and clarity on the areas of focus, which will be updated and augmented as necessary, for the success of ***Water for Life***. The current research strategy is intended to provide the framework for that implementation.

3.0 Vision, Mission, Values and Goals

Vision

Albertans have the knowledge required and use that knowledge to ensure the long term safety, health and sustainability of our water resources.

Mission

The ongoing provision, to Albertans and to Alberta's water managers and decision makers, of the knowledge and solutions necessary to achieve the goals of ***Water for Life***: safe secure drinking water, healthy aquatic ecosystems and reliable quality water supplies for a sustainable economy.

Values

Research, development, and knowledge transfer will be conducted for the benefit of all Albertans and will be built on the principles established by the Alberta Science and Research Authority including:

- shared responsibility for achieving outcomes
- pan-Alberta approach to developing solutions
- collaboration
- integration
- industry partnership
- international standards of excellence in water research and management
- global context for developing and delivering knowledge
- stakeholder accountability

Goal 1

To provide science-based information, analysis and technologies to inform and support the decisions and actions needed for effective water management in Alberta.

Goal 2

To develop an integrated, effective water research system in Alberta that is focused on meeting the strategic knowledge and research needs of ***Water for Life***, and on translating knowledge into action.

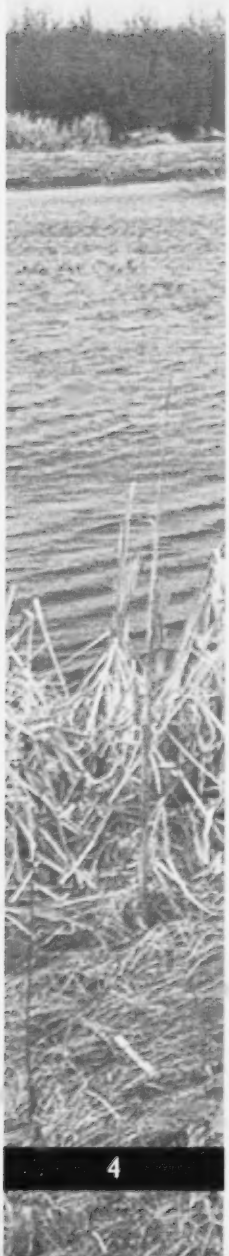


Photo Credits from top to bottom
Wood Frog, Elk Island National Park – Travel Alberta
Pelican, Bow River, Calgary – Travel Alberta

4.0 Research and Innovation Strategies and Priorities

To accomplish Alberta's water research goals, the following strategies must be implemented. These strategies expand upon the goals, and relate directly to the ***Water for Life*** goals of safe secure drinking water, healthy aquatic ecosystems and reliable quality water supplies for a sustainable economy. For each strategy an initial focus area is identified, as are other areas of high priority. A more detailed description of research questions in these and other areas is found in Appendix 3.

Goal 1

To provide science-based information, analysis and technologies to inform and support the decisions and actions needed for effective water management in Alberta.

Strategies

Strategy 1

Improve the safety and security of Albertans' drinking water through knowledge and research — identify, develop, and deliver knowledge, analysis and technologies to ensure, consistently, a high quality of drinking water for large and small municipalities and rural Alberta.

Initial priority

Water treatment technologies and systems to ensure a high standard of public health, especially in areas reliant on private or small water treatment systems.

Other priorities include:

- the water delivery system and regulatory framework
- water quality monitoring systems
- health impacts of novel and multiple contaminants

Strategy 2

Foster improved management of water in the landscape through knowledge and research — identify, develop, and deliver knowledge and analysis to improve understanding of the natural processes in aquatic ecosystems, and to determine appropriate standards, technologies and mechanisms to protect and restore aquatic ecosystems.

Initial priority

Understanding and measuring aquatic ecosystem health.

Other priorities include:

- in-stream flow needs assessments and tool development
- wetlands and riparian areas
- land-use and cumulative impacts of agricultural, municipal and industrial development
- institutional structures and planning processes for effective integrated watershed management
- identifying and implementing improved water management practices
- impacts of climate change and variability on water resources

Strategy 3

Improve sustainability of water use through knowledge and research — identify, develop, and deliver knowledge, analysis and technologies to ensure reliable water supplies for a sustainable economy, and make progress toward increasing the productivity and efficiency of water use in Alberta by 30 per cent.

Initial priority

Understanding ground water resources and interactions with surface water.

Other priorities include:

- improved water allocation systems and transfers for industry and agriculture
- technologies, economic instruments, and management tools for water use, conservation and reuse
- wastewater technologies and management

Goal 2

To develop an integrated, effective water research system in Alberta that is focused on meeting the strategic knowledge and research needs of ***Water for Life***, and on translating knowledge into action.

Strategies

Strategy 4

Develop a water knowledge management and brokering function to support water management decision making. This function will require partnerships within and outside Alberta.

Initial priority

Develop a comprehensive knowledge brokering and transfer mechanism or office.

Other priorities to be met through this mechanism or office include:

- Developing networks among water researchers and research organizations, other knowledge providers, water managers, users and decision makers provincially, nationally and internationally, to facilitate knowledge exchange throughout the system,
- Developing a practical system for identifying and collecting knowledge needs and gaps, and prioritizing action,
- Developing mechanisms for identifying knowledge sources, and for knowledge acquisition, development and deployment in priority areas, and
- Increasing awareness of water issues among Albertans.

Strategy 5

Establish a collaborative governance and leadership mechanism to develop and manage an integrated water research system to address the knowledge and research priorities of ***Water for Life***. The structure must provide for stakeholder governance, co-ordinate the diverse elements of Alberta's water research system, and complement other water, land and resource related research strategies of the province.

Initial priority

Establishing the leadership mechanism to work on behalf of government, the Alberta Water Council and ASRA to implement the research strategy.

Other priorities include:

- Identifying deliverables and recommending mechanisms for managing the Government of Alberta's investment in water research towards ***Water for Life*** outcomes, and
- Regularly updating the water research strategy and, working with the stakeholders, refine and/or expand the priority areas as necessary for the success of ***Water for Life***.

Strategy 6

Create multi-disciplinary, high quality, adequately resourced research and innovation teams. These teams will be strategically focused on developing the new knowledge, understanding and technologies needed for water management, and will be closely connected to the knowledge brokering and management system. These teams will play the key role in the development and implementation of detailed research and knowledge plans.

Initial priority

Establish action teams to develop and implement the knowledge and research plans needed to achieve the three outcomes of ***Water for Life***.

Other priorities include:

- Create teams for developing technologies and methods for improving Alberta's surface and groundwater quality and quantity, monitoring and inventory, and exploring the social, economic, legal and regulatory aspects of water management, and
- Create teams in other priority areas.

5.0 Success Through Partnership

The provision of knowledge and research to achieve the ***Water for Life*** goals will require a co-ordinated effort from the water use, management and research communities, and significant commitment by the Government of Alberta. Success will require action in partnership with The Alberta Water Council, Alberta's Watershed Planning and Advisory Councils, the Alberta Science and Research Authority, multiple government departments, other levels of government, the research community, and perhaps most importantly Alberta's water users, stakeholders and managers.

Success will also require the establishment of national and international partnerships to assist in leveraging Alberta's investment in water research and avoiding duplication of effort. Leading national and international research organizations have been identified, as have some of the opportunities and challenges present in the national and international arenas (Appendix 2).

6.0 Measuring Success

The leadership responsible for implementing this water research strategy is accountable to their partners for success and especially to the Government of Alberta, the Alberta Water Council and the Alberta Science and Research Authority. The leadership group will measure success of the ***Water Research Strategy*** through the effectiveness of knowledge brokering that facilitates the collection, creation, transfer and application of knowledge by Alberta's water users, stakeholders and managers toward the responsible stewardship of Alberta's water resources and aquatic ecosystems.

Specific measures will be developed as the knowledge brokering function and associated structure(s) and partnerships are more fully defined, but ultimately, the Water Research Strategy is designed to achieve the goals and outcomes of ***Water for Life***.

The following table defines the broad areas in which measures will be developed:

Water Research Strategy Objective	Indicator
Creation and acquisition of knowledge, technologies and solutions	In areas of strategic focus: ■ number of national and international research and development collaborations ■ number of water research publications ■ number of technologies developed or adapted for Alberta use
Knowledge uptake in water management	■ access and use of new and imported knowledge by Albertans and water managers
An effective water research system	■ external water research funding ■ attraction of highly qualified water researchers and water managers to Alberta

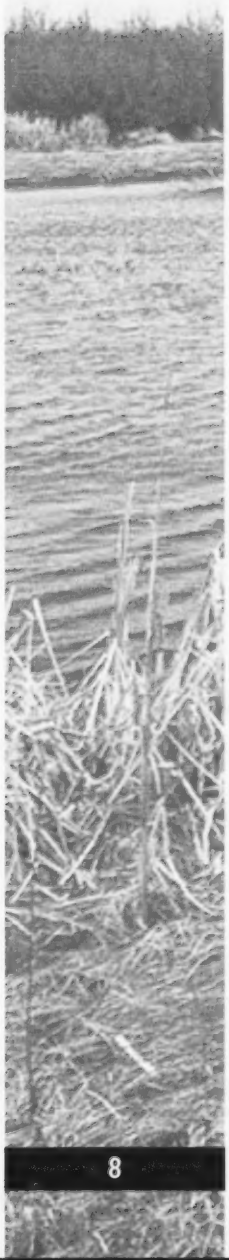
7.0 Sustained Funding and Implementation

Sustained funding is necessary when implementing a research strategy of this magnitude. The sourcing, acquisition, creation and application of knowledge to address Alberta's water management issues requires a long term commitment.

An ongoing annual investment by the Government of Alberta of approximately $10 million will be required. This will support the research, knowledge planning and implementation activities required to achieve the goals of Water for Life. These funds will attract investment and be leveraged through collaboration with industry, other government partners and water stakeholders.

The early implementation steps for the Water Research Strategy are defined in the following table:

Implementation step	Target date
ASRA and Alberta Water Council approval	January 2006
Government of Alberta approval	April 2006
Alberta Water Research Leadership established	First meeting April 2006
Knowledge management and brokering mechanism established and operational	June 2006
Funding mechanism established	June 2006
Research implementation — action teams	
Research & knowledge plans developed	August 2006
Research & knowledge programs initiated	December 2006



Appendix 1: Alberta's Water Research System: Strengths, Weaknesses, and Characteristics

During the development of the Water Research Strategy, several strengths and weaknesses of the Alberta water research system were identified. The overall capacity and capability of the system could be enhanced to address the knowledge and research requirements of ***Water for Life***.

The strengths include:

- investment in the Alberta Ingenuity Center for Water Research
- some world-class researchers, including six Canada Research Chairs
- high participation of Albertan researchers in the Canadian Water Network
- diverse natural laboratory with alpine, boreal forests, woodlands, and semi-arid prairies
- high interest among undergraduate students in environmental engineering and sciences
- creation of the Alberta Water Council that is governing the implementation of ***Water for Life***
- strong water consulting industry
- extensive on-farm monitoring of environmental conditions by Alberta Agriculture, Food and Rural Development

The weaknesses include:

- lack of competitive intelligence on new water technologies and best practices in water management around the world
- insufficient long term funding for water research
- limited information on the water research system in Alberta
- lack of co-ordination of the water research system
- weak linkages and poor communication between water researchers, water stakeholders and resource managers
- segmentation of water research by industry
- limited interdisciplinary research
- no comprehensive water science information system
- weak knowledge management and transfer

Alberta's Water Research Capacity

An initial assessment of water and water related R&D activity in Alberta has provided a relative indication of the size and direction of water related R&D activities in Alberta. The following table provides a partial summary of Alberta's principle water research capacity:

Organization	Existing Water Research capacity
Alberta Ingenuity Centre for Water Research	■ Partnership of Universities of Alberta, Calgary, and Lethbridge involving 40 research experts ■ Eleven Theme Leaders in the areas of Watersheds, Water Ecology, Safety of Water & Wastewater, and Economics, Policy & Risk
University of Alberta	■ Hydrology, Ecology and Disturbance (HEAD) ■ The Hydrology Centre ■ Water Resources Engineering ■ Forest Hydrology Lab ■ Water Resources Centre ■ Forty-two water-related researchers, and one Tier 1 Canada Chair in wastewater engineering ■ Sustainable Forest Management Network
University of Calgary	■ Institute for Sustainable Energy, Environment, and Economy ■ Alberta Ingenuity Centre for Upgrading Technologies ■ Kananaskis and Hydrology Field Stations ■ Pine Creek Centre for Sustainable Water Resources (planned) ■ Twenty-four water related researchers and one Tier 1 Canada Chair in aquatic ecosystems
University of Lethbridge	■ Water Institute for Semi-arid Ecosystems ■ Canadian office for UN ***Water for Life*** initiative ■ Alberta Ingenuity Centre for Water Research (administration) ■ Fifteen water researchers including two Tier 1 and two Tier 2 Canada Research chairs
Alberta Research Council	■ Life Sciences, Energy, Integrated Research Management and Engineered Products Divisions all conduct some form of water research ■ Twenty scientists in applied water research
Industry	■ Canadian Oil Sands Network for Research and Development ■ Petroleum Technology Alliance of Canada ■ Syncrude Canada, Shell Canada, and Nova Chemicals ■ Millar Western and Alberta Pacific
Edmonton Waste Management Center of Excellence	■ Partnership of City of Edmonton, University of Alberta, Alberta Research Council, NAIT, Olds College, and AMEC E&E
Water Utilities	■ Epcor (City of Edmonton) ■ City of Calgary
Alberta Government	■ Agriculture, Food and Rural Development ■ Sustainable Resource Development ■ Alberta Environment ■ Infrastructure and Transportation ■ Health & Wellness — provincial water testing laboratory

Appendix 2: National and International Arena: Opportunities and Challenges

In the process of reviewing Alberta's strategic framework in the national and international arena, leading national and international water research organizations and their corresponding strategies were identified:

- American Water Works Association Research Foundation (AWWA)
- Canadian Water Network
- Environmental Protection Agency: Office of Research and Development
  - Drinking Water & Water Quality Research Programs (U.S.)
- European Union Water Initiative
  - *Water for Life*
  - Water Framework Directive (WFD)
- Global Water Research Coalition (GWRC)
- Grand Water Research Institute (Israel)
- National Water Research Institute (Canada)
- Suez Environmental (France)
- United States Geological Survey
  - Toxic Substances Hydrology (Toxics) Program
  - Ground Water Resources Program
  - Hydrologic Research and Development
  - State Water Resources Research Institute Program (U.S. National Institutes for Water Resources)
- Veolia Water (France)
- Water Environment Research Foundation (WERF)
- Water Research Commission (South Africa)

A number of opportunities were identified within this national and international context:

- participation in major water research consortiums, including the GWRC, WERF, and AWWA
- leveraging external knowledge and expertise in areas such as:
  - research and technology solutions for small water and wastewater systems
  - knowledge and tools for aquatic ecology
- benefiting from experiences of other jurisdictions in addressing sustainable water supplies
- attracting external funding from international water companies, U.S. Federal agencies, the Canadian Government, and water research foundations
- monitoring investment decisions in water and wastewater infrastructure, and
- access to specialized water research infrastructure in other jurisdictions

A number of challenges were also identified in the national and international context that must be considered in the implementation of Alberta's water research strategy:

- internationalization of the water industry, with the consolidation of water research at corporate headquarters in Europe
- significant cuts in water research by many of the international water companies as a result of weak financial results and deregulation
- stagnant U.S. Federal water research funding
- competition among universities and research institutes for water research, and the establishment of numerous new centres and institutes
- low research and development expenditures by municipalities and water users in North America
- basin specific water knowledge required to apply general principles and technologies, and
- retirements and shifts in focus of water researchers in North America

Appendix 3: Research Questions

Water research encompasses an enormous array of highly interrelated themes and specific research questions. The ***Water for Life*** goals—safe, secure drinking water, healthy aquatic ecosystems and reliable quality water supplies for a sustainable economy — cannot be used to conveniently organize water research, as many research areas (e.g. groundwater or cumulative impacts) are important for achieving all three goals. The following list of themes, research questions and knowledge gaps is provided to identify and organize the main research and knowledge elements identified during the development of ***Water for Life*** and the Water Research Strategy. Further consideration of these questions and knowledge gaps will be necessary as the Water Research Strategy is implemented, and detailed research plans are developed.

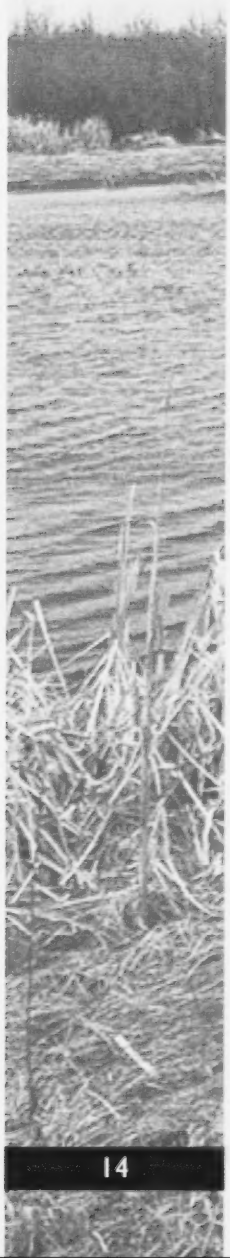
Theme	Research Questions	Knowledge Gap
Ecosystem Water Quality	■ Is the quality of Alberta's surface waters and ground waters being diminished significantly by human activities or other causes? ■ What are the suitable biotic indicators to assess eco-system health?	■ synergistic effects of pollutants and contaminants ■ cumulative effects of pollutants and contaminants from agricultural, municipal and industrial sources ■ groundwater movement of pathogens and toxins ■ protection/preventative measures — less contaminants introduced into surface and groundwater ■ evaluation of non-point source contamination of shallow groundwater
Contamination Prevention	■ What improvements could help prevent the possibility of contamination of surface and groundwater in Alberta?	■ blue-green algae, bacteria and virus remediation ■ are hormones a concern — remediation approaches?
Contamination Remediation	■ What are the best methods and technologies to remediate contaminated surface and ground waters in Alberta?	■ groundwater remediation approaches ■ best methods for testing and remediation for contaminated natural systems, small public and private water systems ■ improvements for large public water systems (viral agents, terrorism)

Appendix 3: Research Questions continued

Theme	Research Questions	Knowledge Gap
Drinking Water Safety	■ What are the best ways to protect all Albertans from health risks related to drinking water? ■ What is the scope of water borne diseases and health risks in Alberta?	■ best "early warning" system for public water systems ■ capacity of existing treatment facilities to deal with emerging (new) risks ■ aquatic ecosystem condition indicators ■ assess the use of tools for assessing aquatic ecosystem health ■ establish and test links of predictive models to biological responses ■ relationship of habitat structure on biological productivity ■ riparian area functions and relationships to aquatic ecosystems
Surface Water Quantity and Flow	■ How will surface water sources provide sustainable support for future growth in population and economy while maintaining the aquatic environment? ■ What innovative tools and methodologies can be used to assess in-stream requirements?	■ glacier contributions to summer flows ■ comprehensive in-flow needs (IFN) models ■ continue development of flow management tools and models ■ predictive model — capacity to withdraw water from Alberta rivers given aquatic ecosystem requirements ■ land use change impact on water resources ■ testing of fish habitat IFN in meeting other IFN
Groundwater Quantity and Flow	■ How will groundwater sources provide sustainable support for future growth in population and economy... without degrading groundwater quality and quantity?	■ consolidated groundwater database (by basin) ■ synthesize groundwater data into integrated databases (prediction, availability, appropriate use) ■ expand mapping of aquifers

Appendix 3: Research Questions continued

Theme	Research Questions	Knowledge Gap
Wetlands and Lakes	■ What changes in characteristics and capacity are evident in our lakes and wetlands? ■ What economic instruments can be used to prevent the loss of wetlands on private property?	■ how wetland degradation affects various ecosystem functions ■ on-farm economics of drainage and conversion of wetlands into agricultural production ■ carbon sequestration in wetlands, and ■ changes in lakes from intensive recreational use and shoreline development
Surface Water to Groundwater	■ How do changes in characteristics and capacity of surface waters affect groundwater?	■ interaction between surface and groundwater (deep and shallow) ■ modelling tools for an integrated water management plan
Basin Management and Planning Processes	■ What is the best way for governments and citizens to work together for effective basin planning and management? ■ What are the implications of intra-basin or inter-basin transfer on aquatic ecosystems?	■ quality/quantity relationships related to interbasin transfer ■ best guidelines for aquatic ecosystem management given climate change ■ identify additional potential water storage and diversion schemes ■ economic growth model and database to allocate water demand by sector on a river basin and regional basis ■ basin planning and decision-making approaches ■ incorporate sustainable ecosystem components into economic model ■ establish a water demand baseline case for future demand forecasting

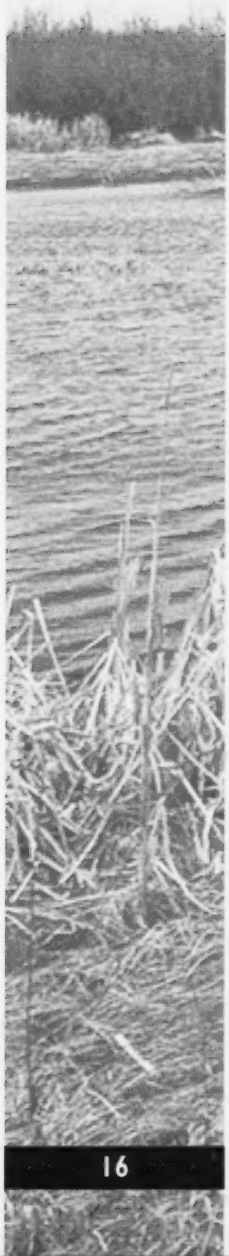


Appendix 3: Research Questions continued

Theme	Research Questions	Knowledge Gap
Cumulative Effects Assessment and Decision Making	■ How can cumulative effects knowledge be incorporated into decision processes?	■ cumulative effects of oil and gas, forestry, mining and other resource-based activities ■ cumulative effects models and assessment tools
Wastewater Treatment	■ Are there more effective technologies and biological remediation approaches for treating effluent after human use? ■ How can the impact of enhanced oil recovery, coal bed methane, and oil sands tailings on water be minimized?	■ improved technologies — bio-remediation, phyto-remediation ■ recycling and re-use technologies ■ use of wetlands ■ waste water and effluent management
Water Conservation	■ What conservation practices can be used to ease demand for water in Alberta, especially as it relates to the agricultural, energy, and industrial sectors? ■ How are these practices effectively introduced into broad use?	■ impact of water metering on small volume users ■ effect of water pricing on water use ■ recycling and re-use of water
Flood and Drought Forecasting	■ How can we help people anticipate flood and drought situations? ■ What can society and individuals do to adapt to these situations and minimize the impacts?	■ improvements in ability to forecast and respond to drought and flood
Social Legal and Economic Issues	■ What are the social, legal and economic issues that limit the ability to successfully manage water resources? ■ What mechanism(s) will be used to resolve conflicts among water users within basins?	■ true economic value of water ■ human behavior and decision making with respect to water use ■ legal and economic frameworks for efficient water allocation
Modeling the present and future "water balance"	■ How will the availability and use of water change over time given various climate and water management scenarios?	■ lack of comprehensive modeling tools ■ water cycle input and output factors impacts and their interactions

Appendix 4: *Water for Life* Strategy Map

Outcomes	Alberta Government Commitment	Short (2004/05-2006/07)
Safe, secure drinking water supply	Albertans will be assured that their drinking water is safe.	A comprehensive strategy is underway to protect Albertans' drinking water: ■ Alberta's drinking water program is assessed by an independent expert on an ongoing basis (starting in 2005 and repeated every five years), ■ All drinking water facilities and associated operations are evaluated, ■ Municipal grant criteria support the development of regional water systems, and ■ Emergency response protocols are in place and supported by staff and laboratory capacity to protect Albertans from contaminants in drinking water.
Healthy aquatic ecosystems	Albertans will be assured that the province's aquatic ecosystems are protected and maintained.	Efforts to protect aquatic ecosystems in critical areas are underway: ■ Water Conservation Objectives are established for the South Saskatchewan River Basin, ■ Alberta's wetland policy is reviewed and updated, and a supporting action plan is developed to achieve sustainable wetlands, ■ A system for monitoring and assessing aquatic ecosystems is developed, and ■ Science-based methods for determining the ecological requirements of healthy aquatic ecosystems are established.
Reliable, quality water supplies for a sustainable economy	Albertans will be assured that water is managed effectively to support sustainable economic development.	A broad range of water management tools and techniques are implemented: ■ Water allocation transfers are authorized within all watersheds, ■ The full cost of water provided by Alberta's water management infrastructure is determined, ■ Transboundary agreements are developed and implemented co-operatively with neighbouring jurisdictions, and ■ Alberta's water resources are managed on the "first-in-time, first-in-right" principle, using all the tools within the Water Act.



Targets	
Medium (2007/08-2009/10)	Long (2010/11-2013/14)
Albertans have full and complete knowledge of drinking water issues and real-time access to information about the drinking water quality in their community: ■ All drinking water facility sample test results are available to Albertans through a drinking water website, ■ All Albertans on private drinking water systems have received educational information, and ■ All drinking water facilities have adopted the multi-barrier/source-to-tap approach.	Alberta's drinking water infrastructure is upgraded to meet emerging standards and to ensure sustainable operations: ■ All drinking water facilities are upgraded to meet new drinking water standards, ■ Drinking water for all provincial parks and recreation areas meets new drinking water standards, ■ Regional water systems are designed and implemented, and ■ A waterborne health surveillance and reporting system is operational.
Water management objectives and priorities for sustaining aquatic ecosystems are established through watershed plans. ■ An initial assessment of the status of aquatic ecosystems — lakes, wetlands, streams and rivers — is completed, and ■ Objectives for aquatic ecosystems — lakes, wetlands, streams and rivers — are established in concert with watershed management plans.	Water is managed and allocated to sustain aquatic ecosystems and ensure their contribution to Alberta's natural capital and quality of life are maintained. ■ The state of Alberta's aquatic ecosystems — lakes, wetlands, streams and rivers - are known, and ■ Aquatic ecosystems — lakes, wetlands, streams and rivers — are maintained in a healthy state and enhanced in situations where conditions do not meet established objectives.
Water management objectives and priorities to support sustainable economic development are established through watershed plans: ■ The water allocation transfer system is monitored, evaluated and reported to Albertans, ■ Alberta's water management system is administered and operated to meet transboundary agreements, and ■ Water management infrastructure needs are evaluated as part of the watershed planning process.	Water is managed and allocated to support sustainable economic development and the strategic priorities of the province: ■ The water allocation transfer system is a viable market that moves water into uses that support sustainable economic development, and ■ Alberta's water infrastructure (provincial and district-owned) is managed for long-term sustainability.

Alberta Science and Research Authority

500 Phipps-McKinnon Building
10020 – 101A Ave.
Edmonton, AB T5J 3G2

Tel: (780) 427-1488
Fax: (780) 427-0979
Dial 310-0000 for toll-free access throughout Alberta
Email: asra@gov.ab.ca
http://www.asra.ab.ca

MADE WITH 100% RECYCLED PAPER

ISBN 0-7785-4710-8

Back cover photo credit – Alberta Research Council